CLAIMS:

1. A lightweight, low density fiber comprising:

a polyester copolymer for providing a greater elasticity than a corresponding monomer-based polyester;

more than thirty five percent functional void fraction in the form of foam-forming cells for reducing the density of the fiber as compared to a solid fiber;

at least five void cells per axial cross section for increasing the structural integrity of the fiber as compared to less uniform foams; and

submicron-sized particles of an inert nucleating agent, present in an amount less than 10 percent by weight.

2. A foamed fiber according to Claim 1 wherein said inert nucleating agent is selected from the group consisting of fluorocarbon polymers, polytetrafluoroethylene, and silicone.

3. A foamed fiber according to Claim 1 having a denier of between about 6 and 15.

4. A foamed fiber according to Claim 1 having between about 50 and 75% functional void fraction.

5. A foamed fiber according to Claim 1 having between about 6 and 30 cells per cross section.

6. A foamed fiber according to Claim 1 having a smooth surface.

7. A foamed fiber according to Claim 1 having a fibrillated surface for increasing the moisture transfer capabilities of the fiber.

8. A foamed fiber according to Claim 1 having a channeled surface.

9. A foamed fiber according to Claim 1 having a pitted surface.

10. A foamed fiber according to Claim 1 wherein said copolymer comprises polyester and polyethylene glycol, with the polyethylene glycol being present in an amount of between about 6 and 10 percent by weight.

11. A foamed fiber according to Claim 1 having a density of between about 0.4 and 0.6 g/cm^3.

13. A foamed fiber according to Claim 1 having open and closed cells.

14. A fabric comprising fibers according to Claim 1.

15. A fabric according to Claim 14 selected from the group consisting of woven fabrics, knitted fabrics and non-woven fabrics.

16. A foamed fiber according to Claim 1 comprising about one percent by weight of said submicron particles of fluorocarbon polymer.

17. A lightweight, low density foamed fiber according to Claim 1 consisting essentially of:

a copolymer of polyester and polyethylene glycol in which the glycol is present in an amount of between about 6 and 10 percent by weight;

between about fifty and seventy five percent functional void fraction;

between about 6 and 30 cells per axial cross section; and

submicron-sized particles of polytetrafluoroethylene, present in an amount less than 10 percent by weight.

18. A foamed fiber according to Claim 17 having a density of between about 0.4 and 0.6 g/cm^3.

19. A fabric comprising fibers according to Claim 17 and selected from the group consisting of woven fabrics, knitted fabrics and non-woven fabrics.

20. A low density, light weight fiber according to Claim 1 comprising a non-uniform surface for providing additional mechanical properties to the foamed fiber as compared to corresponding smooth surface fiber.

21. A fabric formed from the foamed fiber according to Claim 20 and selected from the group consisting of woven fabrics, non-woven fabrics, and knitted fabrics.

22. A method of producing a foamed fiber in a continuous technique, the method comprising:

dissolving an inert blowing agent in an amount sufficient to generate at least about 35% void fraction in resulting spun filaments in its liquid state in a polyester copolymer to form a solution of the blowing agent in the copolymer;

mixing an inert nucleating agent with the polyester copolymer in an amount sufficient to increase the number of cells that the blowing agent will generate as compared to blowing agent alone under the same conditions, but less than an amount that adversely affects the spinning process;

adding the solution and nucleating agent mixture in the liquid state to an extruder;

forwarding the mixture to a spinneret at a higher than normal polyester extrusion pressure to give extra shear and encourage expansion of the blowing agent as the filaments leave the spinneret; and

spinning the mixture into filaments through the spinneret.

23. A method according to Claim 22 further comprising:

quenching the filaments in an otherwise conventional manner; and

thereafter taking up and drawing the filaments in a combined spin-drawing step.

24. A method according to Claim 22 comprising maintaining a sufficient pressure in the extruder to keep the dissolved blowing agent in solution at the temperature of the liquid copolymer solution.

25. A method according to Claim 22 wherein the step of forwarding the mixture at higher than normal pressure comprises filtering the mixture at a higher than normal pressure.

26. A method according to Claim 22 comprising dissolving the blowing agent in an amount of between about 2 and 10 percent by weight based on the weight of the copolymer.

27. A method according to Claim 22 comprising dissolving the blowing agent in an amount of between about 4 and 5 percent by weight based on the weight of the copolymer.

28. A method according to Claim 22 comprising dissolving a fluorinated hydrocarbon as the blowing agent.

29. A method according to Claim 28 wherein the blowing agent comprises CF_3CH_2F.

30. A method according to Claim 22 wherein the step of mixing the nucleating agent with the polyester copolymer comprises:

preparing a masterbatch of the nucleating agent and the polyester copolymer with the nucleating agent present in a higher proportion than desired for extrusion; and

thereafter mixing the masterbatch with additional polyester copolymer until the concentration of nucleating agent in the copolymer reaches the extrusion amount.

31. A method according to Claim 30 comprising preparing a masterbatch of submicron particles selected from the group consisting of silicone and fluorinated

hydrocarbon as the nucleating agent with a copolymer of polyethylene terephthalate and polyethylene glycol.

32. A method according to Claim 30 comprising preparing a masterbatch that is about 5 percent by weight of nucleating agent and thereafter mixing one part of the masterbatch with between about 3 and 9 parts of the copolymer.

34. A method according to Claim 22 wherein the step of mixing the nucleating agent with the polyester copolymer comprises mixing a nucleating agent in the solid state with polymer chips.

35. A method according to Claim 23 comprising heat setting the filament.

36. A method according to Claim 30 comprising preferentially directionally quenching the spun filaments to thereby develop different degrees of orientation across the filaments that produce self-crimping when the preferentially-quenched filaments are heat-set.

37. A method according to Claim 22 comprising texturing the spun filaments.

38. A method of forming a low density filament according to Claim 22 comprising spinning the mixture into hollow filaments through the spinneret by extruding the filaments as adjacent pairs of c-shaped filaments that join as they are passively or actively quenched to form a hollow filament with a sheath foamed by the blowing agent during the extrusion from the spinneret.

39. A method according to Claim 38 comprising filtering the mixture at higher than normal polyester extrusion pressure to give extra shear and encourage expansion of the blowing agent as the filaments leave the spinneret.

40. A self-crimping filament comprising:

a polyester copolymer;

at least about 40% void space by volume

more than 5 cells per axial cross section; and

different degrees of orientation along at least two adjacent longitudinal portions of the filament.

41. A self-crimping filament according to Claim 40 comprising between about 45 and 75% void space by volume.

42. A self-crimping filament according to Claim 40 wherein said polyester copolymer comprises between about 6 and 10 percent by weight of polyethylene glycol.

43. A self-crimping filament according to Claim 40 comprising between about 6 and 30 cells per axial cross section.

44. A self-crimping filament according to Claim 40 comprising submicron sized solid particles of a fluorocarbon polymer in an amount not exceeding about two percent by weight.

45. A self-crimping filament according to Claim 40 having a denier of between about 6 and 15.

46. A self-crimping filament according to Claim 40 having a density of between about 0.4 and 0.6 grams per cubic centimeter.

47. A fabric formed from the self-crimping filament according to Claim 40 and selected from the group consisting of woven fabrics, non-woven fabrics and knitted fabrics.

48. A low density light weight fiber comprising:

a polyester copolymer for providing a greater elasticity than a corresponding monomer-based polyester;

a hollow core for reducing the overall density of the fiber compared to a solid fiber; and

a foamed sheath for further reducing the overall density as compared to a solid-sheath hollow fiber.

49. A low density light weight fiber according to Claim 48 wherein said polyester copolymer comprises polyethylene glycol present in an amount of between about 6 and 10 percent by weight.

50. A low density light weight fiber according to Claim 48 comprising submicron sized particles of a fluorocarbon polymer and present in an amount not exceeding two percent by weight.

51. A low density light weight fiber according to Claim 48 wherein said foamed sheath has a void fraction of at least about 35 percent by volume.

52. A low density light weight fiber according to Claim 48 having a density of between about 0.3 and 0.7 grams per cubic centimeter.

53. A low density light weight fiber according to Claim 48 having a density of between about 0.45 and 0.55 grams per cubic centimeter.

54. A fabric formed from the fiber according to Claim 48 and selected from the group consisting of woven fabrics, non-woven fabrics and knitted fabrics.

55. A low density fiber comprising:

polyester; and

irregular longitudinal surface effects that in length are at least an order of magnitude greater than the average diameter of the fiber and that in width are at least an order of magnitude smaller than the average diameter of the fiber.

56. A low density fiber according to Claim 55 having a density no greater than 1.10 grams per cubic centimeter.

57. A low density fiber according to Claim 55 having a density no greater than 0.75 grams per cubic centimeter.

58. A low density fiber according to Claim 55 comprising a copolymer of polyester and polyethylene glycol in which the polyethylene glycol is present in an amount of between about 6 and 10 percent by weight.

59. A low density fiber according to Claim 55 comprising submicron particles of a fluorocarbon polymer present in an amount of no more than about 2 percent by weight.

60. A fabric formed from the low density fiber according to Claim 55 and selected from the group consisting of woven fabrics, non-woven fabrics, and knitted fabrics.

61. A process for melt extrusion of thermoplastic foam comprising:

extruding a molten mixture of an elastic thermoplastic polymer with a melt viscosity of at least about 1000 poise at extrusion temperature, and a molecular relaxation time of at least about 1 millisecond;

and containing an additive comprised of insoluble particles in the size range from about 50 nanometers to about 500 nanometers, at an additive level from about 0.1% to about 1.0% by weight;

and containing a dissolved blowing agent in an amount sufficient to generate a gas pressure from about 5 atmospheres to about 200 atmospheres at extrusion temperature;

through a nozzle at a flow rate sufficient to generate a wall shear rate exceeding 1000 per second.

62. A melt extrusion process according to Claim 61 comprising extruding a polymer with a melt viscosity of between about 1000 and 20,000 poise

63. A melt extrusion process according to Claim 61 comprising extruding a polymer at an extrusion temperature of between about 260 and 310 °C.

64. A melt extrusion process according to Claim 61 comprising extruding polyester as the thermoplastic polymer.

65. A melt extrusion process according to Claim 61 comprising extruding a copolymer of polyester and polyethylene glycol, with the polyethylene glycol being present in an amount of between about 6 and 10 percent by weight of the copolymer.

66. A melt extrusion process according to Claim 61 comprising extruding a mixture in which the insoluble particles are selected from the group consisting of silicone and polytetrafluoroethylene.

67. A melt extrusion process according to Claim 61 further comprising:
quenching the filaments in an otherwise conventional manner; and
thereafter taking up and drawing the filaments in a combined spin-drawing step.

68. A melt extrusion process according to Claim 67 comprising a post-quench draw-down ratio greater than 100:1.

69. A melt extrusion process according to Claim 61 comprising dissolving the blowing agent in an amount of between about 2 and 10 percent by weight based on the weight of the copolymer.

70. A melt extrusion process according to Claim 61 wherein the blowing agent comprises CF_3CH_2F (Freon 134a).

71. A melt extrusion process according to Claim 61 comprising extruding the mixture at a pump pressure of between about 500 and 3000 psi.

72. A melt extrusion process according to Claim 61 comprising extruding a mixture in which the intrinsic viscosity of the polymer is less than 0.7.

73. A foamed thermoplastic fiber or film article containing elongated voids wherein:

the smallest linear dimension of said article does not exceed 0.5 mm;

the average cross sectional diameter of the included voids does not exceed about 20% of the smallest linear dimension;

the length of said voids is at least 2 times longer than their diameter; and

said voids are present in sufficient number to comprise at least 10% of the volume of said thermoplastic article.